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# (54) Title: SYNTHETIC THERMOPLASTIC COMPOSITIONS AND ARTICLES MADE THEREFROM

**(57) Abstract:** Synthetic plastic compositions, made from a mixture of thermoplastic and a mineral composition containing Cristobalite and aluminum oxide, produce articles that exhibit improved tear and compression strength, while having less weight by using less plastic resin per article. These articles have a more uniform surface with significantly reduced sink marks. The molding machine making articles with these compositions exhibits an increase in throughput. Running these synthetic plastic compositions through injection, extrusion and blow molding machines also cleans and lubricates the screw and the injector nozzles, increasing the life of the mold parts. The elemental composition of the mineral comprises silicon dioxide, aluminum oxide, potassium oxide, iron oxide, calcium oxide, titanium oxide, and trace elements, with the silicon dioxide and aluminum oxide predominating. The majority of the silicon dioxide in the mineral is in the form of Cristobalite. The mineral composition is typically present in amounts of 0.5% or more, by weight of the thermoplastic. The mineral composition is added to the thermoplastic in a manner that provides uniform dispersion throughout the thermoplastic. The mineral may be added as dry power, in particle sizes varying from 6 to 75 microns, to the plastic resin. The mineral composition may also be added directly to the plastic resin in pellet or pellet composition form of various sizes.

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# SYNTHETIC THERMOPLASTIC COMPOSITIONS AND ARTICLES MADE THEREFROM

## BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to improvements in synthetic thermoplastic compositions and articles made from such synthetic thermoplastic compositions.

2. Description of Related Art

Plastics are moldable chemically-fabricated (synthetic) materials derived mostly from fossil fuels, such as oil, coal or natural gas. Other forms of materials such as glass, metals and clay, which are not plastics, are also moldable. The key difference between these materials and plastics is that plastics consist of long molecules, while glass, metals and clay consist of short molecules. Plastics are indispensable to the modern way of life. Plastics are found everywhere, in pillows, mattresses, blankets, carpets, the cars we drive, the computers we use, cooking utensils, recreational equipment, houses, telephones, compact discs, plumbing fixtures, boats and furniture, for example. The average 1998 model car contains almost 136 kilograms (almost 300 pounds) of plastics. This is nearly 12% of the vehicle's overall weight.

Plastics consist of very long molecules each composed of carbon atoms linked into chains. One type of plastic, polyethylene is composed of extremely long molecules, each containing over 200,000 carbon atoms. These long molecule chains

give plastics unique properties and distinguish plastics from materials such as metals that have short crystalline molecular structures. Fossil fuels contain hydrocarbons, which provide the building blocks for long polymer molecules. The building blocks called monomers link together to form long carbon chains called polymers. The process of forming these long molecules from the hydrocarbons is called polymerization. The molecules typically form viscous sticky substances known as resins which are the materials used to make plastic products or articles. Another plastic, ethylene, is a gaseous hydrocarbon. When it is subjected to heat, pressure and certain catalysts, the ethylene molecules join together into long repeating carbon chains. These joined molecules form the plastic polyethylene. The carbon backbone of polymer molecules often bond with smaller side chains consisting of other elements, including chlorine, fluorine, nitrogen and silicon. These side chains give plastics some distinguishing characteristics. For example, when chlorine atoms substitute for hydrogen atoms along the carbon chain, the result is polyvinyl chloride, one of the most versatile and widely used plastics in the world. The addition of chlorine makes this plastic harder and more resistant. The advantages and disadvantages of different plastics are associated with the unique chemistry of each plastic. For example, longer polymer molecules become more entangled, like spaghetti noodles, giving plastics containing these longer polymers high tensile strength and high impact resistance. However, these plastics are more difficult to mold.

All plastics can be basically divided into two groups: thermoplastics and thermosetting plastics. The two groups differ in the way that the plastics in those groups respond to heat. Thermoplastics can be repeatedly softened by heating and

hardened by cooling. Thermosetting plastics harden permanently after being heated once. The present invention is concerned with the thermoplastic family of plastics.

Thermoplastics have molecules that are linear and slightly branched and do not chemically bond with each other when heated. Thermoplastic chains are held together by weak van der Waal forces that cause a long molecule chain to clump together like piles of entangled spaghetti. This allows the thermoplastics to be heated and cooled and consequently softened and hardened repeatedly, like candle wax.

Different kinds of thermoplastics may be grouped according to the arrangement of their molecules. Highly aligned molecules arrange themselves more compactly, resulting in a stronger plastic. For example, molecules in nylon are highly aligned making this thermoplastic extremely strong. The degree of alignment of the molecules also determines how transparent a plastic is. Thermoplastics with highly aligned molecules scatter light which makes these plastics appear opaque. Thermoplastics with semialigned molecules scatter some light which makes most of these plastics appear translucent. Thermoplastics with random molecular arrangements do not scatter light and are clear. These clear, or amorphous, thermoplastics are used to make optical lenses, windshields and other clear products.

The process of forming plastic resins into products is the basis of the plastics industry. Many different processes can be used to make products from thermoplastics. Some of the more important of these processes are injection molding, extrusion, blow molding, blow film extrusion, calendaring, thermoforming, casting and expansion processes. In all these processes, the plastic must be softened or sufficiently liquefied to be shaped.

Injection molding is a process which uses a piston or screw to force plastic resin through a heated tube into a mold where the plastic cools and hardens to the shape of the mold. The mold is then opened and the plastic cast is removed. Articles that are made this way include toys, combs, guardrails and various containers.

Extrusion is a continuous process, as opposed to all other plastic production processes which start over at the beginning of the process, after each new article is removed from the mold. In the extrusion process, plastic pellets are first heated in a long barrel. In a manner similar to that of a pasta making, or sausage stuffing machine, a rotating screw forces the heated plastic through a die opening which is the desired shape of the product. As the continuous plastic form emerges from the die opening, it is cooled and solidified, and the continuous plastic form is then cut to the desired length. Articles made according to this process include garden hoses, drinking straws, pipes, ropes and plastic fence material. Melted thermoplastic forced through extremely fine die molds can be cooled and woven into fabrics for clothing, curtains and carpets.

Blow molding is used to make bottles and other containers from soft, hollow thermoplastic tubes. A mold is first fitted around the outside of the softened thermoplastic tube. Then the tube is heated, and air is blown into the softened tube, similar to inflating a balloon, which forces the outside of the softened tube to conform to the inside walls of the mold. Once the plastic cools, the mold is opened and a newly molded container is removed. This molding process is used to make many plastic containers such as soft drink bottles, jars, detergent bottles and storage drums.

Blow film extrusion is a process that is used to make plastic garbage bags and continuous sheets of plastic. Blow film extrusion extrudes a hollow sealed-end

thermoplastic tube through a die opening. As the flattened plastic tube emerges from the die opening, air is blown inside the hollow tube to stretch and thin the tube, like a balloon being inflated to the desired shape and wall thickness. It is then air cooled and pulled away on take-up rollers to a heat sealing operation. The heat sealer cuts and seals one end of the thin flat thermoplastic tube creating various bag lengths for products, such as plastic grocery and garbage bags. To make sheeting, the thin plastic tube is slit along one side and opened to form a continuous sheet.

Calendaring is a process that forms continuous plastic sheets that are used to make flooring, wall siding, tape and other products. The plastic sheets are made by forcing hot thermoplastic resin between heated rollers called calendars. A series of secondary calendars further thin the plastic sheets. Paper, cloth and other plastics may be pressed between layers of calendared plastic to make items such as credit cards, playing cards, and wallpaper, for example.

Thermoforming is a term used to describe several different techniques for making products from plastic sheets. Products made from thermoformed sheets include trays, signs, briefcase shells, refrigerated door liners and packages. Thermoforming involves the use of a vacuum-forming process wherein hot thermoplastic sheets are draped over a mold. Air is removed from between the mold and the hot plastic sheet creating a vacuum that draws the plastic into the cavities of the mold. When the cavities cool, the molded product is removed. In the pressure forming process, compressed air is used to drive a hot plastic sheet into the cavities and depressions of a concave or female mold, vent holes in the bottom of the mold allow trapped air to escape.

Casting is a process that is similar to that of molding plaster or cement. Fluid thermoplastic resin is poured into a mold and additives cause the resin to solidify. Photographic film is made by pouring a fluid solution of resin onto a highly polished metal belt. A thin plastic film remains as the solution evaporates. The casting process is used to make furniture parts, table tops, sinks and acrylic window sheets.

The expansion process injects gases such as nitrogen or methychloride into the plastic mold. As the resin cools, tiny bubbles of gas are trapped inside forming a cellular plastic structure. This process is used to make foam products, such as cushions, sponges, pillows, egg cartons and polystyrene cups. These foam plastics can be classified according to their bubble or cell structure. Sponges and carpet pads are examples of open cell foam plastics in which the bubbles are interconnected. Flotation devices, on the other hand, are examples of closed cell foam plastics in which the bubbles are sealed like tiny balloons. Foam plastics are also classified by density, that is the ratio of the plastic to the cells, by the type of plastic resin used, and by flexibility. For example, rigid closed cell polyurethane plastics make excellent insulation for refrigerators and freezers.

Of all the plastics, thermoplastic materials are in high demand because they can be repeatedly softened and remolded. The most commonly used thermoplastics are polyethylene (PE), polyvinyl chloride (PVC), polypropylene (PP), polystyrene (PS), polyethylene terephthalate (PET), acrylonitrile butadiene styrene (ABS), polymethyl methacrylate (PMMA), and polyamide (PA).

Polyethylene (PE) resins are milky white, translucent substances derived from ethylene. Polyethylene is made in low and high density forms. Low density Polyethylene (LDPE) has a density ranging from 0.91 to 0.93 grams per cubic

centimeter (0.602 - 0.61 ounces per cubic inch). The molecules of LDPE have a carbon backbone with side groups of 4 to 6 carbon atoms attached randomly, along the main backbone. LDPE is the most widely used of all plastics because it is inexpensive, extremely tough and chemical-resistant. LDPE is traditionally molded into bottles, garment bags, frozen food packages and plastic toys.

The other form of polyethylene, high-density polyethylene (HDPE), has a density that ranges from 0.94 to 0.97 grams per cubic centimeter (0.62 to 0.64 ounces per cubic inch). Its molecules have an extremely long carbon backbone with no side groups. As a result, these molecules align into more compact arrangements accounting for the higher density. HDPE is stiffer, stronger and less translucent than LDPE. HDPE is formed into grocery bags, car parts, fuel tanks, packaging and piping.

Polyvinyl chloride (PVC) is prepared from the organic compound vinyl chloride. PVC is the most widely used of the amorphous plastics. PVC is lightweight, durable and waterproof. The chlorine atoms bonded to the carbon backbone of its molecules give PVC its hard, flame resistant properties. In its rigid form, PVC is weather resistant. It is generally extruded into pipe, house siding and gutters. Rigid PVC is also blow molded into clear bottles and is used to form other consumer products, such as compact discs and computer casings. PVC can be softened with certain chemicals. This softened form of PVC is used to make shrink-wrap film, food packaging, rainwear, shoe soles, shampoo containers, floor tile, gloves, and upholstery. Most softened PVC products are manufactured by extrusion, injection molding or casting.

Polypropylene (PP) is polymerized from the organic compound propylene. Because the most common form of polypropylene has the methyl groups all on one

side of the carbon backbone, polypropylene molecules tend to be highly aligned and compact, giving this thermoplastic the properties of durability and chemical resistance. Many polypropylene products, such as rope, fiber, luggage, carpet and packaging, are formed by injection molding.

Polystyrene (PS) is produced from styrene and has phenol groups attached in random locations along the carbon backbone of the molecule. The random attachment of benzene prevents the molecules from becoming highly aligned. As a result, polystyrene is an amorphous, transparent and somewhat brittle plastic. Polystyrene is widely used because of its rigidity and superior insulation properties. It can undergo all thermoplastic processes to form products, such as toys, utensils, display boxes, model aircraft kit parts and ball point pen barrels. Polystyrene is also expanded into foam plastic, such as packaging materials, egg cartons, flotation devices and Styrofoam.

Polyethylene terephthalate (PET) is formed from a reaction of terephthalate acid and ethylene glycol. PET molecules are highly aligned creating a strong and abrasion resistant material that is used to produce films and polyester fibers. PET is injection molded into windshield wiper arms, sunroof frames, gears, pulleys and food trays. PET is used to make the trademark textiles DACRON, FIBERFIVE, FORTREL and CODEL. Tough transparent PET films marketed under the brand name MYLAR are magnetically coated to make both audio and video recording tape.

Acrylonitrile butadiene styrene (ABS) is made by copolymerizing the monomers, acrolenatryl and styrene. The advantage of ABS is that this material combines the strength and rigidity of acrylonitrile and styrene polymers with the toughness of the polybutadiene rubber. Although the cost of producing ABS is

roughly twice the cost of reproducing polystyrenes, ABS is considered superior for its hardness, gloss, toughness and electrical insulation properties. ABS plastic is injection molded to make telephones, helmets, washing machine agitators and pipe joints. This plastic is thermoformed to make luggage, golf carts, toys and car grills. ABS is also extruded to make piping to which pipe joints are easily solvent-cemented.

Polymethyl methacrylate (PMMA), also known by the generic name Acrylic, is polymerized from the hydrocarbon compound methylmecatholate. PMMA is a hard material and is extremely clear because of the amorphous arrangement of its molecules. As a result, this thermoplastic is used to make optical lenses, watch crystals, aircraft windshields, skylights and outdoor signs. These PMMA products are marketed under familiar trade names, such as Plexiglass, Lucite and Acrolyte. Because PMMA can be cast to resemble marble, it is also used to make sinks, counter tops and other fixtures.

Polyamides (PA), known by the trade name Nylon, consists of highly ordered molecules which give polyamides high tensile strength. Some polyamides are made by reacting dye carbodicarboxylic acid with diamines. Other types of PA may be synthesized by the condensation of amino acids. Polyamides have properties, such as high abrasion resistance and low coefficients of friction, i.e., they are slippery, and have tensile strengths comparable to the softer of the aluminum alloys. PAs are therefore commonly used for mechanical applications such as gears, bearings and bushings. PA is extruded into millions of tons of synthetic fibers every year. The most commonly used PA fibers are made into textiles, ropes, fishing lines, brushes and other items. Other thermoplastics having specific characteristics have been developed, like polycarbonate, for example, by adding a phenyl ring in the chain; this

provides a thermoplastic that is transparent, heat resistant, flame resistant and remarkably tough.

In addition to these thermoplastics, new and proprietary thermoplastics have been developed for special purposes. Thermoplastics, such as LEXAN, for example, are used for telephone housings, semiconductor material, and water bottles, as well as many other articles.

Because of the importance of thermoplastics to the production of consumer products, and the great number of consumer products made from thermoplastics, the industry is continually searching for ways to improve both the plastic article and the manner in which the article is made. Specifically, the industry wants to create an article that has greater strength, that has better color distribution, and has improved surface smoothness and texture. The industry is looking for a process that reduces cycle time, the amount of time needed to produce each article; cure time, the amount of time needed for the article to be sufficiently hard to be handled; that reduces the amount of material used (shot size), and the overall weight of the article, all without reducing its strength. Although the industry has come up with a variety of processes and compositions to produce thermoplastic articles that have enhanced mechanical and physical properties by adding expensive and sophisticated materials to the mix, such as fumed silica, for example, as described in U.S. Patent No. 5,872,173, these prior art methods still do not provide improvements to the manufacturing process and to the properties of the manufactured articles as does the present invention.

The present invention contemplates the use of a naturally occurring mineral composition as an additive to thermoplastic resin. Although this mineral composition has been mined and used as a finely ground powder as an additive to cementitious

products to enhance the fire retardation characteristics of those products, it was not until the present inventors began experimenting with the addition of this mineral composition to plastics that its unexpected and surprising affect on thermoplastics was discovered. The addition of a small amount of this mineral composition to a thermoplastic resin considerably enhances the toughness and appearance of the manufactured article and enhances the manufacturing process.

## SUMMARY OF THE INVENTION

The present invention is a synthetic plastic composition of thermoplastic and a mineral composition containing silicon dioxide, mostly in the form of Cristobalite, and aluminum oxide, in addition to minor amounts of other elements such as potassium oxide, iron oxide, calcium oxide, titanium oxide, and some trace elements. The mineral composition is added to the thermoplastic resin so that it is uniformly dispersed throughout the resin in an amount that is 0. 5%, or more, by weight of the thermoplastic resin. The resin may be virgin resin, a mixture of virgin and a recycled mix, or a mixture of different thermoplastic resins in virgin or recycled form. The synthetic plastic composition of the present invention produces articles of superior strength, less weight and using less plastic resin per article. The produced articles have a more uniform surface and significantly reduced sink marks. The synthetic plastic compositions of the present invention allow the molding machine to increase throughput while extending the life of the molds and machines themselves.

# BRIEF DESCRIPTION OF THE DRAWINGS

The exact nature of this invention, as well as its objects and its advantages, will become readily appreciated upon consideration of the following detailed description in relation to the accompanying drawings, in which like reference numerals designate like parts throughout the figures thereof and wherein:

Figure 1 is a chart showing the processing advantages to using the mineral composition with polypropylene;

Figure 2 is a chart showing the processing advantages to using the mineral composition with polyethylene;

Figure 3 is a chart showing the manufacturing advantages to using the mineral composition with polyethylene;

Figure 4 is a chart showing the manufacturing advantages to using the mineral composition with polyethylene;

Figure 5 is a chart showing the manufacturing advantages of using the mineral composition with a commingling of thermoplastics including recycled materials;

Figure 6 is a chart showing the manufacturing advantages of using the mineral composition with the proprietary thermoplastic LEXAN;

Figure 7 is a chart showing the manufacturing advantages of using the mineral composition with PVC;

Figure 8 is a chart showing the manufacturing advantages of using the mineral composition with ABS; and

Figure 9 is a chart showing the advantages to articles made from various thermoplastics with the mineral composition mixed in.

## DETAILED DESCRIPTION

## OF THE PREFERRED EMBODIMENTS

The mineral composition mixed in with thermoplastics to produce the thermoplastic compositions of the present invention, and the articles made therefrom is a pure nonmetallic nontoxic vitreous pyroclastic tuff which is naturally occurring, and is mined. It has a unique crystalline structure. The elemental composition of this mineral is:

| | |
|---|---|
| Silicon Dioxide ($Si0_2$) | --- 73.0% |
| Aluminum Oxide ($Al_20_3$) | --- 21.0% |
| Potassium Oxide ($K_20$) | --- 4.7% |
| Iron Oxide ($Fe_20_3$) | --- 0.4% |
| Calcium Oxide (Ca0) | --- 0.5% |
| Titanium Oxide ($Ti0_2$) | --- 0.1% |
| Trace Minerals, i.e., Cl, Ge, Rb, Sr, Y, Zr, and Nb | --- 0.3% |

The percentages provided for each of the elements are illustrative only. Each element may vary up or down in its concentration in the mineral, without affecting the ratio of the key elements $Si0_2$ and $Al_20_3$ in the composition and its effect in thermoplastic.

About 40% of this elemental composition is in crystalline form. The remaining 60% is amorphous. Looking at the crystalline composition only, one sees a very large percentage (75%) of a high temperature quartz crystalline material known as Cristobalite. The other crystalline structures are plagioclase 12%, feldspar 12%, and other forms of quartz 1%.

Quartz is a the second most common of all minerals. It is composed of silicon dioxide ($SiO_2$), also known as silica. It is distributed all over the world as a constituent of rocks and in the form of pure deposits. It is an essential constituent of igneous rocks, such as granite, rhyolite and pegmatite, which contains an excess of silica. In metamorphic rocks, it is a major constituent of various forms of gneiss and schist. The metamorphic rock quartzite is composed almost entirely of quartz. Sandstone, a sedimentary rock, is composed mainly of quartz.

Quartz crystallizes in the rhombohedral system. The size of the crystals vary from specimens weighing a metric ton to minute particles that sparkle in rock surfaces. Quartz is common in massive forms which contain particles ranging in size from course-grained to cryptocrystalline (grains that are invisible to the naked eye and only observable under a microscope). Quartz is a mineral that has a hardness of 7 and a specific gravity of 2.65. In some specimens it has a luster that is vitreous. In others it is greasy or splendent (shining glossily). Some specimens are transparent, others are translucent.

Quartz crystals undergo structural transformations when heated. Ordinary quartz, or low quartz, when heated to 573°C (1063.4°F) is converted into high quartz, which has a different crystal structure and different physical properties. When cooled, high quartz reverts back to low quartz. Between 870° and 1470° C (1598° and

2678° F), quartz exists in a form called tridymite. Above 1470° C (2678° F) the stable form of quartz is known as Cristobalite. This is the highest stable form of quartz before the mineral melts at 1710°C (3078° F). Although it is a form of silicon

dioxide, or silica, Cristobalite is less likely to cause thermal stress, and less likely to fracture under thermal shock, than other forms of silicon dioxide, or silica.

By adding this Cristobalite rich mineral composition to thermoplastic resin, surprising and unexpected improvements in the process of manufacture and the article resulting from the process are obtained. The mineral composition is added dry, in a form of a fine powder, ranging in size from 6 to 75 microns, or in a concentrate, or in a pellet form of any convenient size. The concentrate or pellets may contain a carrier, such as ethyl vinyl acetate (EVA). A preferred concentration or pellet mixture is a 50-50 mixture of the mineral composition and ethyl vinyl acetate.

Regardless of the form of the mineral composition, i.e., powder, pellet or pellet composition, this mineral composition must be added to thermoplastic resin so that it is evenly dispersed throughout the resin. The inventors have noticed that the addition of only 0.5% by weight of the mineral composition to a thermoplastic tends to improve the flow of the resin, appearing to act like a lubricant, which assists in filling the mold cavities of injection molding machines, extrusion machines, or blow molding machines. Higher percentages of the mineral composition produce like advantageous results in addition to providing other advantages. One surprising result is the machines operate at lower pressures and temperatures, while filling the entire mold cavity faster. The lower temperatures reduce the cure time for the article being produced. The result is, the productivity of the machine is increased because the plastic part can be removed from the mold earlier and handled by the operator more quickly and easily. Another surprising and unexpected result of adding the mineral composition to thermoplastic resin is that it promotes the commingling of different thermoplastic resins in the production of a single article. This is of particular

significance. It is well known that combining different thermoplastic resins, which melt at different temperatures, do not produce satisfactory results. By facilitating the combination of different thermoplastic resins into a single product, it allows a manufacturer who produces plastic articles from post-consumer recycled plastic waste to significantly reduce sorting of the plastic waste to be able to produce a satisfactory product from the recycled plastic. Moreover, this combining characteristic allows a manufacturer to mix reground plastic scrap together with virgin plastic resin to produce an article that appears to be produced completely from virgin plastic resin.

Another surprising and unexpected result flowing from the addition of this mineral composition to thermoplastic resin is the increased creation of bubbles or cells in the thermoplastic during the manufacturing process. The action was similar to the action of a foaming or expanding agent. The result was an article of increased strength, with reduced weight.

Another surprising and unexpected result of the addition of this mineral composition to thermoplastic resin is that the article produced exhibited greatly reduced surface imperfections and sink marks.

Besides all these improvements to the articles being produced, the addition of this mineral composition to thermoplastic resin had surprising and unexpected results with respect to the operation of the molding machines themselves. In one of many tests conducted or observed by the inventors, it appeared that an extrusion machine was producing more end product with less strain and difficulty, from a mechanical standpoint. Upon examination of the injection molds and extrusion dies and the injector and extruder screws, the use of the mineral composition with the thermoplastic appeared to have polished and cleaned the molds, dies, and screws.

Other observations by the inventors have shown that the injection molding machines are much cleaner in operation after use of the mineral composition mixed into the thermoplastic resin. The mineral composition appears to act as a purging draft.

The inventors tested this mineral composition in a wide range of plastics in the thermoplastic family and found that when used as an additive, it generally improved the physical properties of the articles and reduced the processing time. Specifically, the inventors noted that operating temperatures and pressures were lower than normally found in injection molding and the other well-known molding techniques used for thermoplastics. The inventors noted a number of improvements in the articles themselves, including eliminating cooling sink marks, relieving of internal mechanical stress, reducing thermoconductivity, improving surface finishes, increasing strength, reducing weight and reducing cycle time by reducing the cooling time of the molded part or article.

Figure 1 is a chart illustrating the percentage reduction on the Y axis 11 against the variables of weight, shot size, cure time and cycle time of the article being produced on the X axis 12. The material utilized for production of the article is polypropylene with 1% by weight of the mineral composition added. The polypropylene mixture was used to make perfume bottle caps. The result of the test showed that the end product weight 13 was reduced by 5%. The amount of plastic that needed to be used, in other words, the shot size 15 was reduced by 10%. The amount of time that was required to cool the product after the material was injected into the mold, the cure time 17 was reduced by 28.6%. The overall cycle time 19 for making each article was reduced by 47.5%. As shown in Figure 9, the final articles

had an improvement in texture 23, the surface smoothness of the article 25, and the color distribution 27 of the article was more even.

Referring now to Figure 2, by adding the mineral composition at 1% by weight to polyethylene of both high-density polyethylene or low density polyethylene. The inventors observed that at 1% by weight the mineral composition reduced the weight 13 of the final article by about 12% and reduced the overall cycle time 19 per article by about 32%, while at the same time causing the article produced, as shown in Figure 9, to have improved surface texture 23, less surface imperfections 25, better color dispersion 27, a lower final temperature out of the mold 29, and increased strength 31.

Figure 3 illustrates the results of tests run by the inventors on both high density and low-density polyethylene with 1.5% by weight of the mineral composition added. The results were that the final weight 13 of the article was reduced by about 5%. The amount of resin that needed to be utilized to make the article, the shot 15, was reduced 27%. The overall cycle time 19 for the article was reduced by 12%. The articles themselves exhibited improved texture 23, surface 25 and color 27 characteristics, with final temperature reduction 29 and increased strength 31, as shown in Figure 9.

Figure 4 shows the results of tests run by the inventors utilizing a mixture that contains 2% of the mineral composition by weight of the polyethylene resin. These test results showed that the amount of resin that needed to be utilized to make the article, the shot size 15, was reduced by about 5%. The cure time 17 for the article was reduced by about 12% and the cycle time 19 for the article was reduced by 14%. In addition, the articles all showed improved structural characteristics as illustrated in

Figure 9, in that the texture 23, the surface 25 and color 27 of the articles were improved. The final temperature 29 was reduced, and the strength 31 of the article was increased.

The molding processes utilized for these tests encompass conventional injection molding, such as by a 700 ton Cincinnati Milacron machine, for example, as well as blow molding, extrusion molding and structural foam machines. The range of articles being produced by these processes include water buckets, bottles, water faucets, milk crates, pill boxes, plastic film, shipping pallets, and railroad ties.

Figure 5 illustrates the results of tests conducted by the inventors on mixed or commingled plastic resin by adding 1.5% or 2 % of the mineral composition to a mixed or commingled thermoplastic resin. The mixed aggregate included mixture of high-density polyethylene plastic in virgin and recycled form, mixture of high-density polyethylene and polypropylene, mixtures of high-density polyethylene and ABS. Figure 5 shows that uniformly throughout the test, either at 1.5% or 2% by weight of the mineral composition, the cycle time 19 for manufacture of the article decreased by about 40%. In addition, the products themselves exhibited a great improvement in texture 23, surface smoothness 25, color distribution 27, and increased strength 31.

Figure 6 illustrates the results of tests conducted on LEXAN, an engineered thermoplastic which is proprietary to G.E. Plastics. In these tests, either 1.5% or 2% by weight of the mineral composition was added to the LEXAN. The test results show that the shot size 15 was reduced by 5%. Cure time 17 was reduced by 48%. Cycle time 19 for the manufacture of the articles was reduced by 30%. In addition, the articles themselves, showed a final temperature reduction 29 as it came out of the mold.

The LEXAN thermoplastic was being used in injection molding machines to make telephone housings and electronic parts.

Figure 7 illustrates the results of tests conducted on polyvinyl chloride. The mineral composition was added at 1% by weight. The results were that the overall weight 13 of the product was reduced by 45%. At the same time, as shown in Figure 9, the strength 31 of the product was increased. The molding process utilized was the extrusion molding to make tubing.

Figure 8 illustrates the results of tests run on ABS resin utilizing a 1.5% by weight of the mineral composition in the mixture. The results were that the cycle time 19 for the articles being manufactured was reduced by about 17%. The process was injection molding. The parts being manufactured were sprinkler heads.

Those skilled in the art will appreciate that various adaptations and modifications of the just-described preferred embodiments can be configured without departing from the scope and spirit of the invention. Therefore, it is to be understood that within the scope of the appended claims, the invention may be practiced other than as specifically described herein.

CLAIMS

It Is Claimed:

1. A synthetic plastic composition comprising a thermoplastic selected from the group consisting of polyethylene, polyvinyl chloride, polypropylene, polystyrene, polyethylene terephthalate, acrylonitrile butadiene styrene, polymethyl methacrylate, polyamide and polycarbonate; and a mineral composition containing at least 10% by weight of Cristobalite, and 10% by weight of aluminum oxide; wherein the mineral composition is uniformly dispersed throughout the thermoplastic in an amount that is at least 0.5% by weight of the thermoplastic.

2. The synthetic plastic composition of Claim 1 wherein the mineral composition comprises:

| | |
|---|---|
| Silicon Dioxide ($Si0_2$) | --- 73.0% |
| Aluminum Oxide ($Al_20_3$) | --- 21.0% |
| Potassium Oxide ($K_20$) | --- 4.7% |
| Iron Oxide ($Fe_20_3$) | --- 0.4% |
| Calcium Oxide (Ca0) | --- 0.5% |
| Titanium Oxide ($Ti0_2$) | --- 0.1% |
| Trace Minerals | --- 0.3% |

3. The synthetic plastic composition of Claim 2 wherein about 40% of the mineral composition is crystalline.

4. The synthetic plastic composition of Claim 3 wherein about 75% of the crystalline portion of the mineral composition is Cristobalite.

5. The synthetic plastic composition of Claim 1 wherein the mineral composition is about 1% by weight of the thermoplastic.

6. The synthetic plastic composition of Claim 1 wherein the mineral composition is about 1.5% by weight of the thermoplastic.

7. The synthetic plastic composition of Claim 1 wherein the mineral composition is about 2% by weight of the thermoplastic.

8. An article comprising a synthetic plastic composition of thermoplastic selected from the group consisting of polyethylene, polyvinyl chloride, polypropylene, polystyrene, polyethylene terephthalate, acrylonitrile butadiene styrene, polymethyl methacrylate, polyamide and polycarbonate, and a mineral composition containing at least 10% by weight of Cristobalite and 10% by weight of aluminum oxide, wherein the mineral composition is uniformly dispersed throughout the thermoplastic in an amount that is at least 0.5% by weight of the thermoplastic.

9. The article of claim 8 wherein the mineral composition comprises a :

| | |
|---|---|
| Silicon Dioxide ($Si0_2$) | --- 73.0% |
| Aluminum Oxide ($Al_20_3$) | --- 21.0% |
| Potassium Oxide ($K_20$) | --- 4.7% |
| Iron Oxide ($Fe_20_3$) | --- 0.4% |
| Calcium Oxide (Ca0) | --- 0.5% |
| Titanium Oxide ($Ti0_2$) | --- 0.1% |
| Trace Minerals | --- 0.3 |

10. The article of Claim 9 wherein about 40% of the mineral composition is crystalline.

11. The article of Claim 10 wherein about 75% of the crystalline parts of the mineral composition is Cristobalite.

12. The article of Claim 8 wherein the mineral composition is about 1% by weight of the thermoplastic.

13. The article of Claim 8 wherein the mineral composition is about 1.5% by weight of the thermoplastic.

14. The article of Claim 8 wherein the mineral composition is about 2% by weight of the thermoplastic.

FIGURE 1

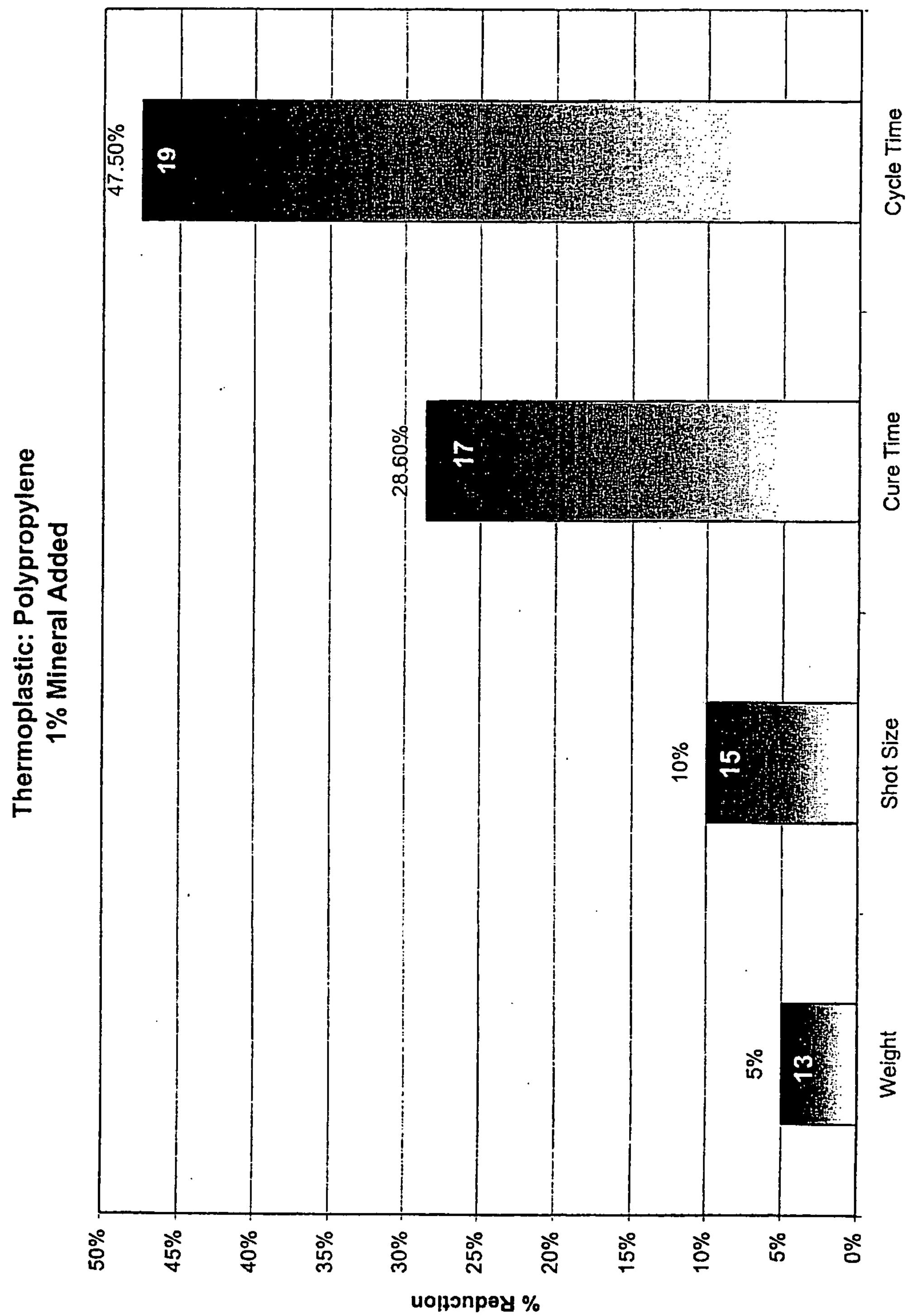

Thermoplastic: Polypropylene
1% Mineral Added
% Reduction
50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
47.50%
19
28.60%
17
10%
15
5%
13
Weight
Shot Size
Cure Time
Cycle Time

FIGURE 2

Thermoplastic: Polyethylene
1% Mineral Added

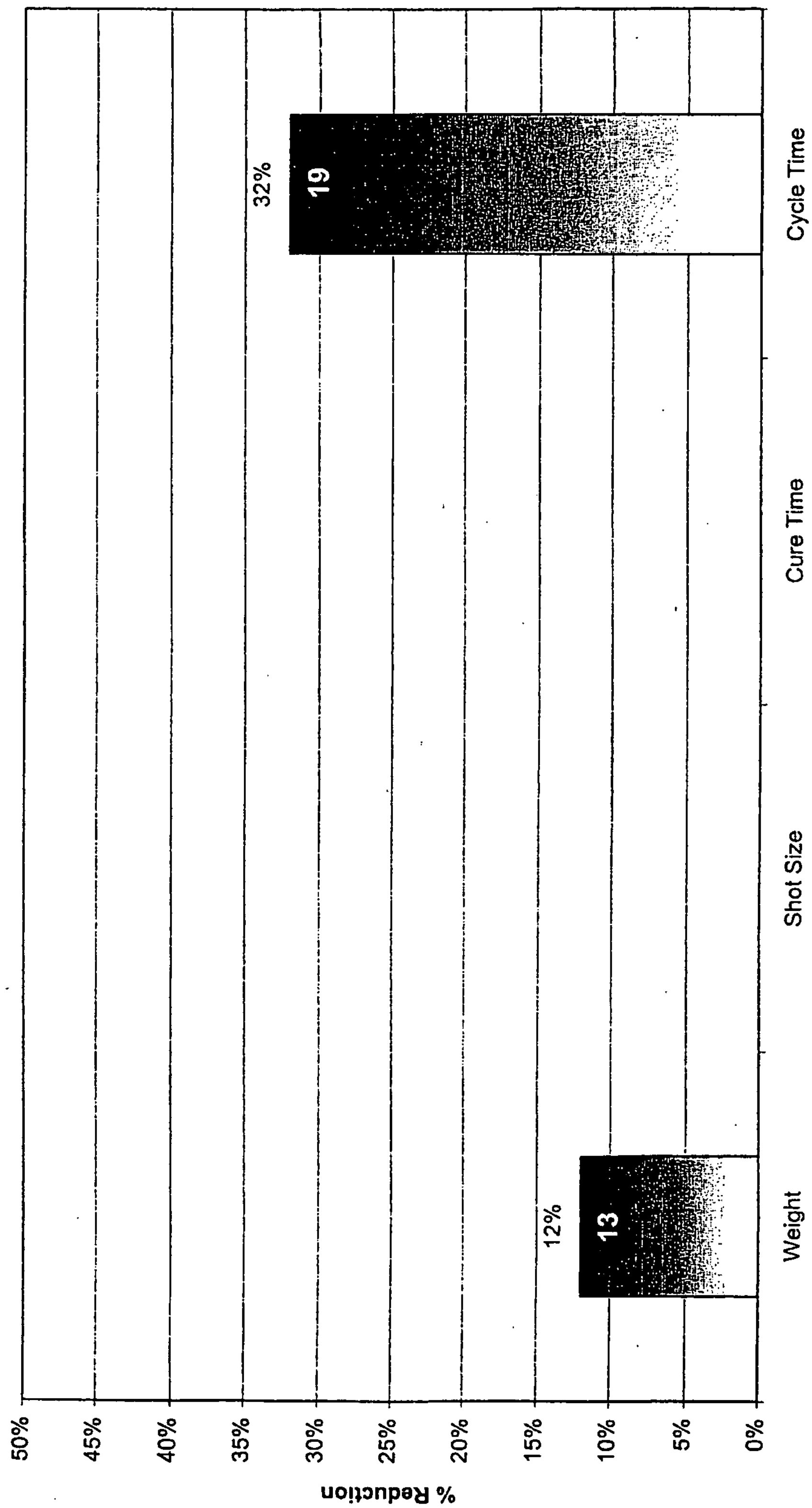


FIGURE 3

Thermoplastic: Polyethylene
1.5% Mineral Added

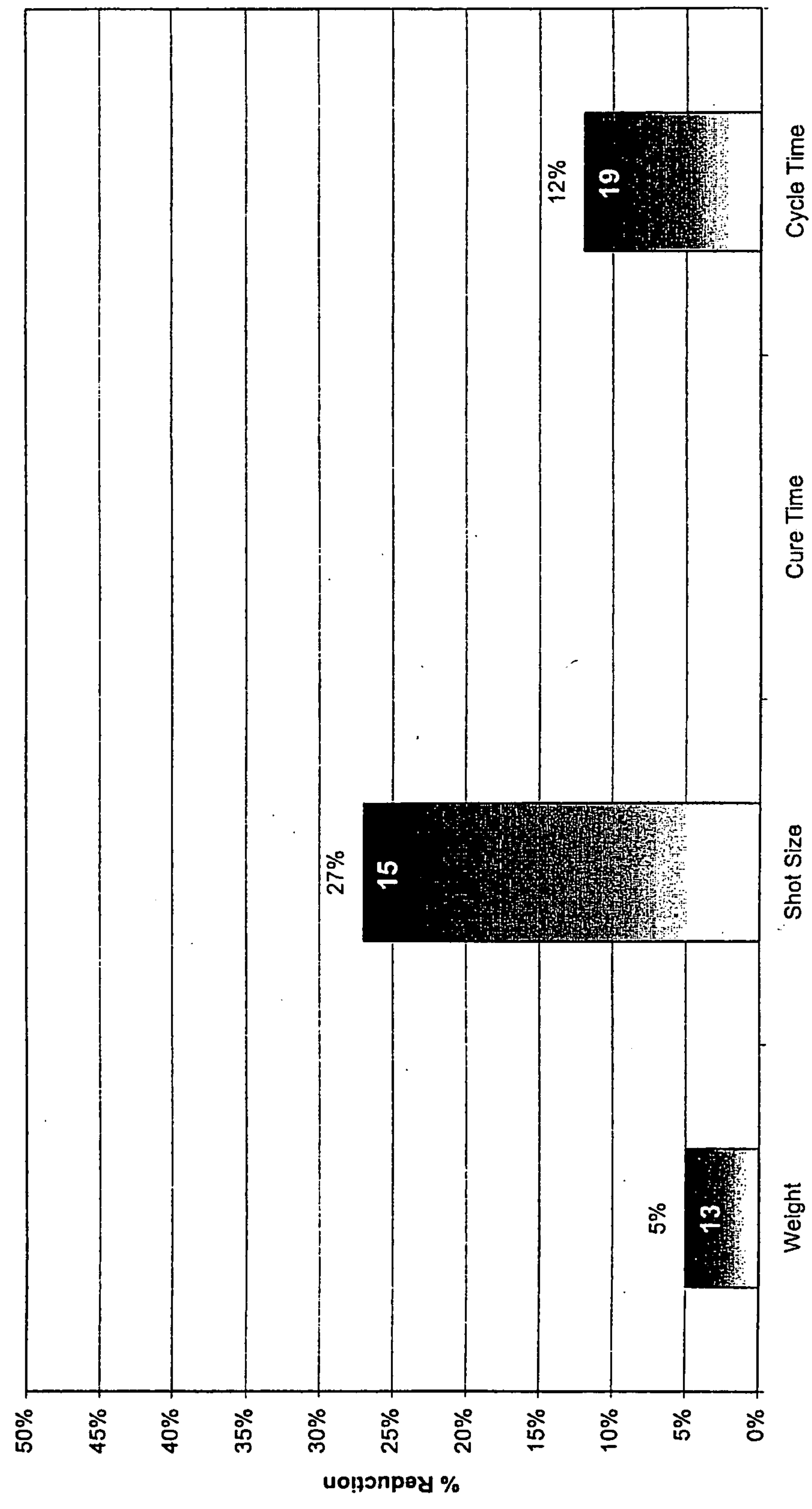


FIGURE 4

Thermoplastic: Polyethylene
2% Mineral Added

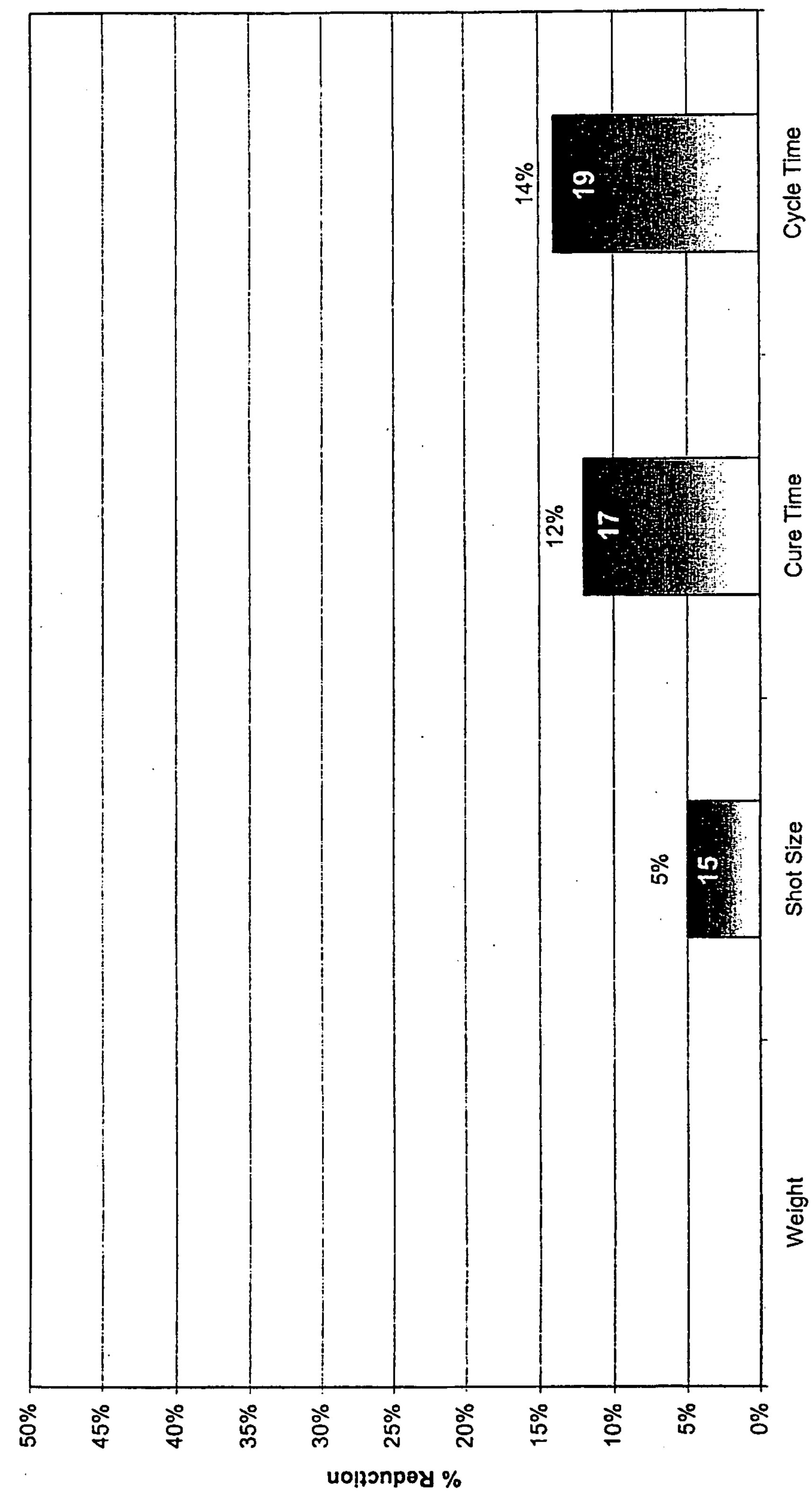


FIGURE 5

Thermoplastic: Mixed or Commingled
1.5% or 2% Mineral Added

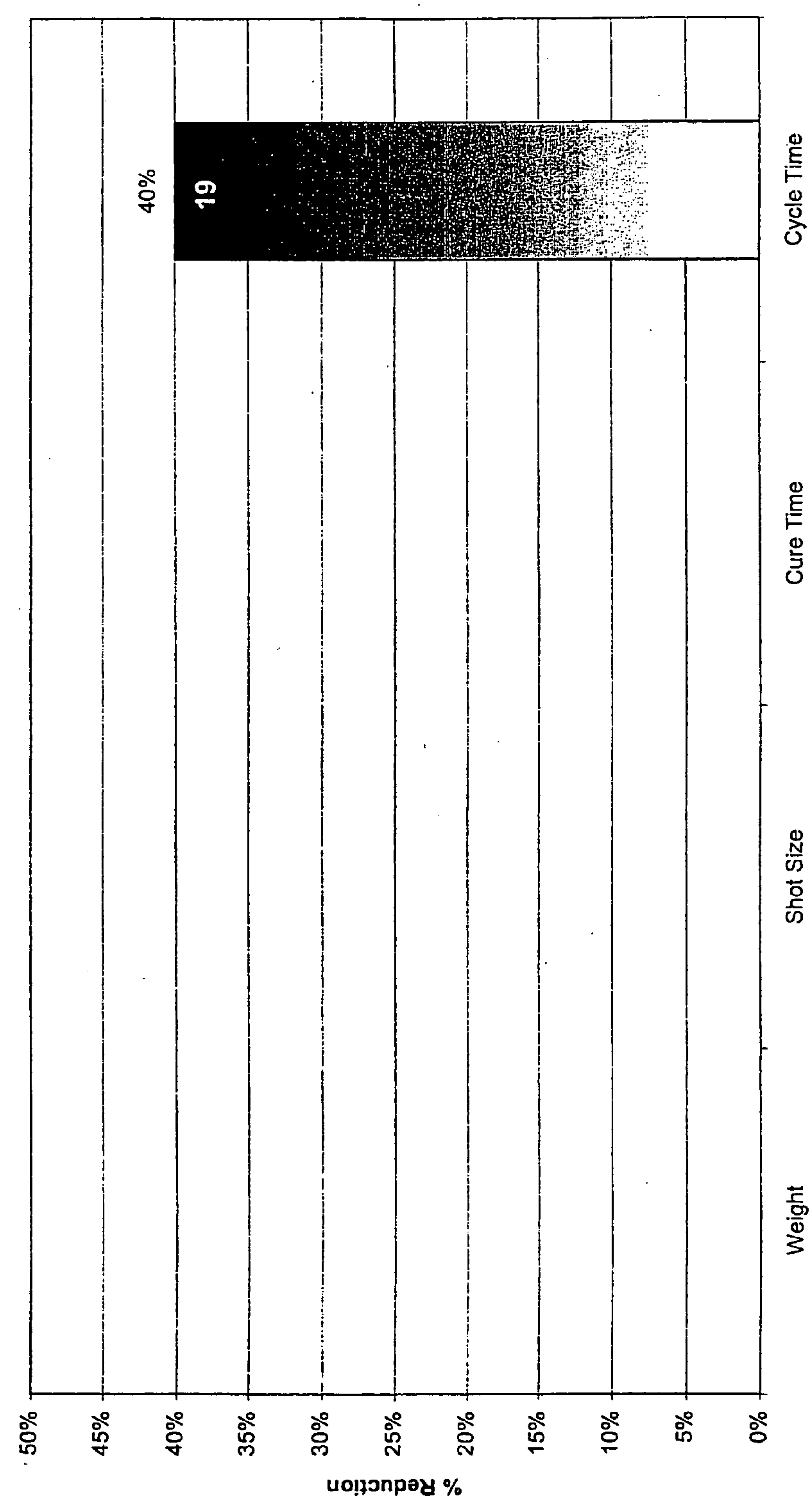


FIGURE 6

Thermoplastic: LEXAN
1.5% or 2% Mineral Added

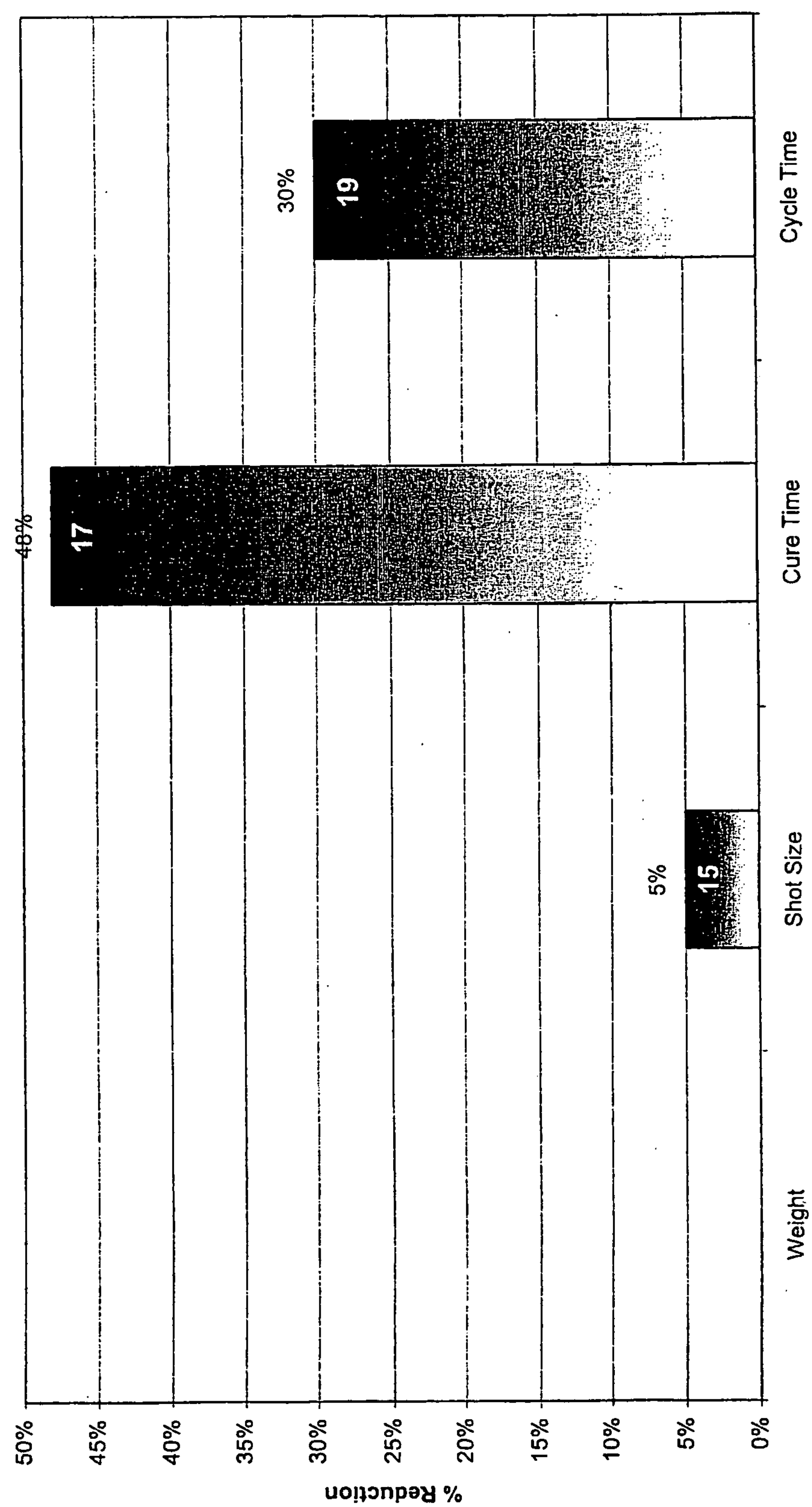


FIGURE 7

Thermoplastic: PVC
1% Mineral Added

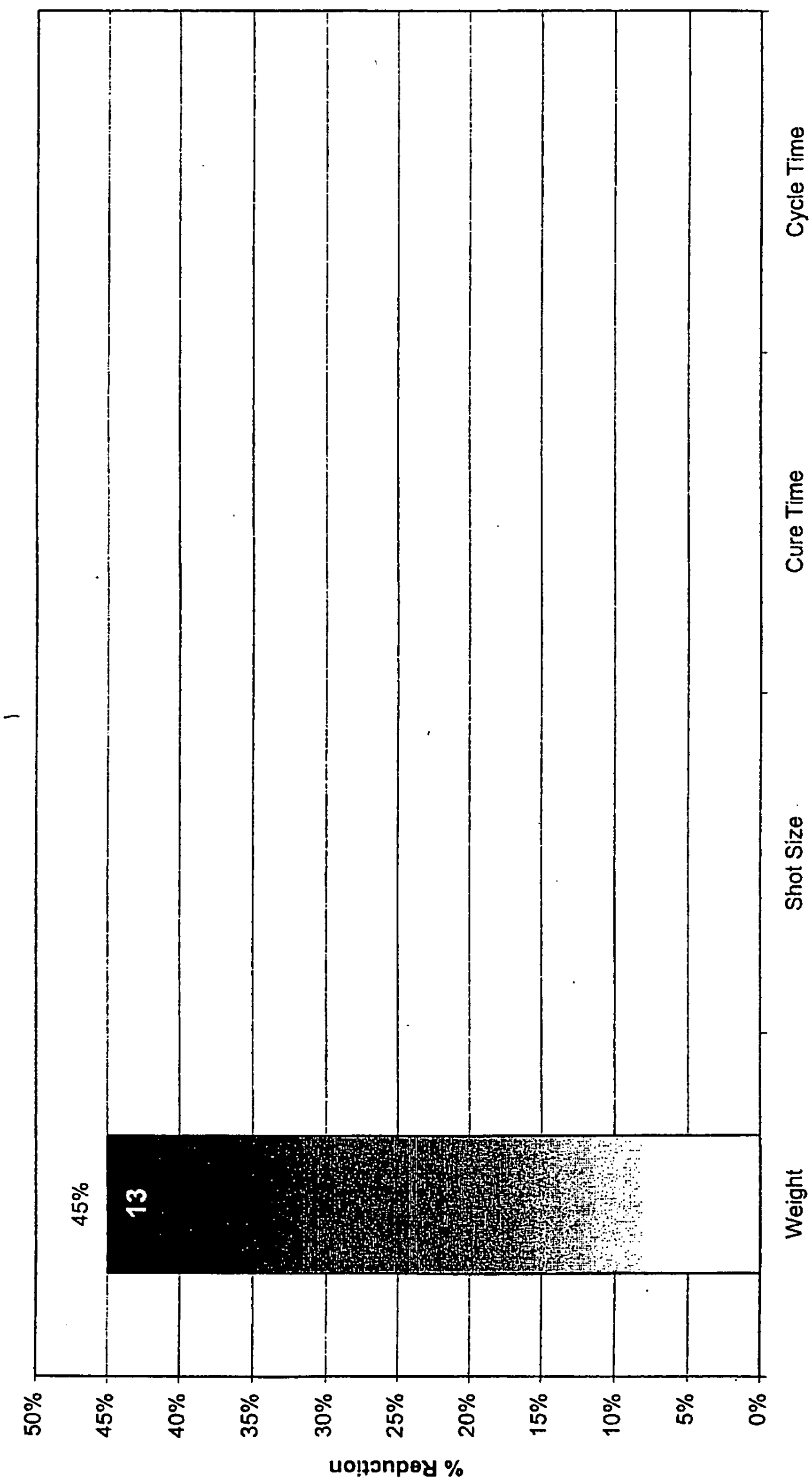


FIGURE 8

Thermoplastic: ABS
1.5% Mineral Added

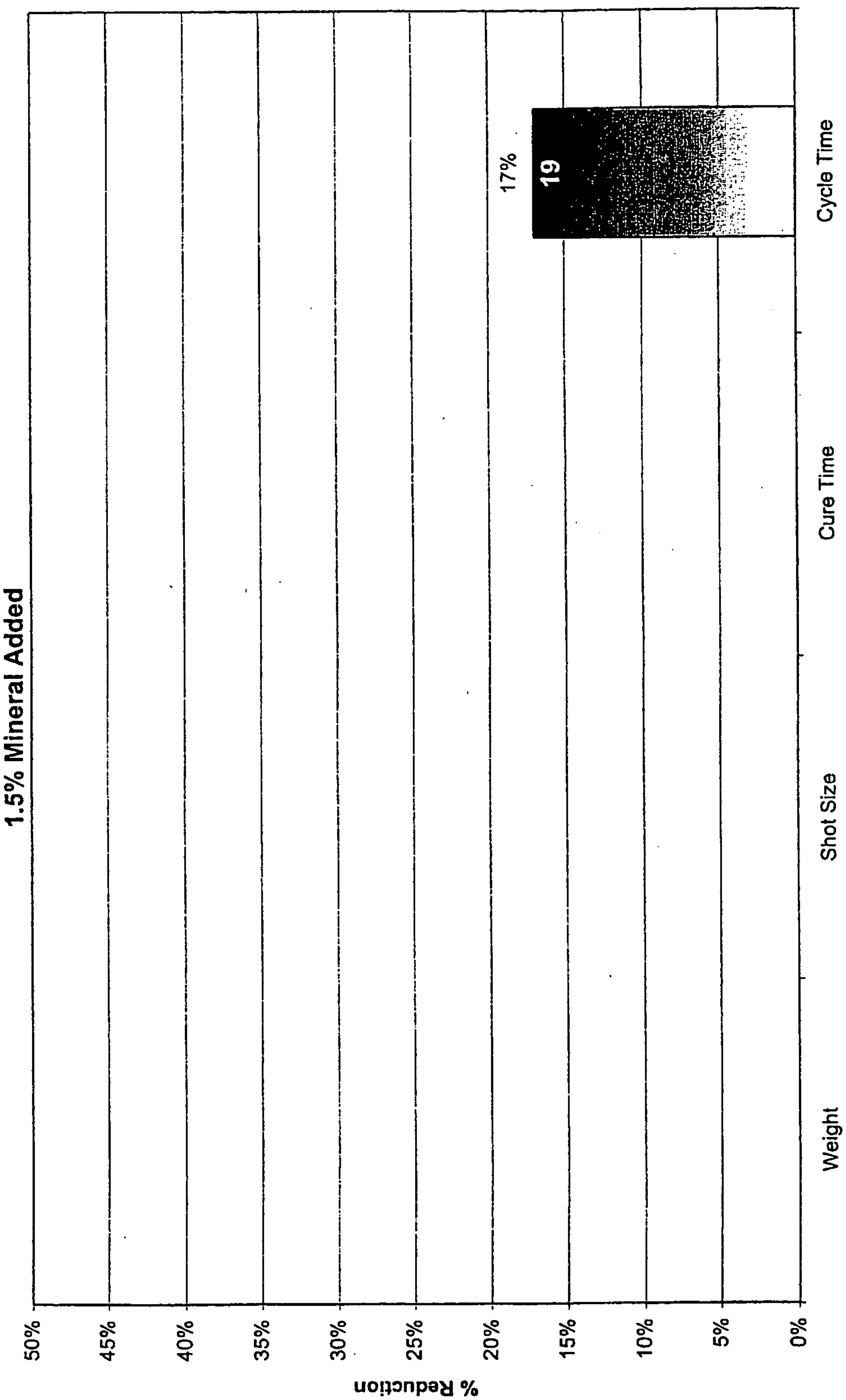
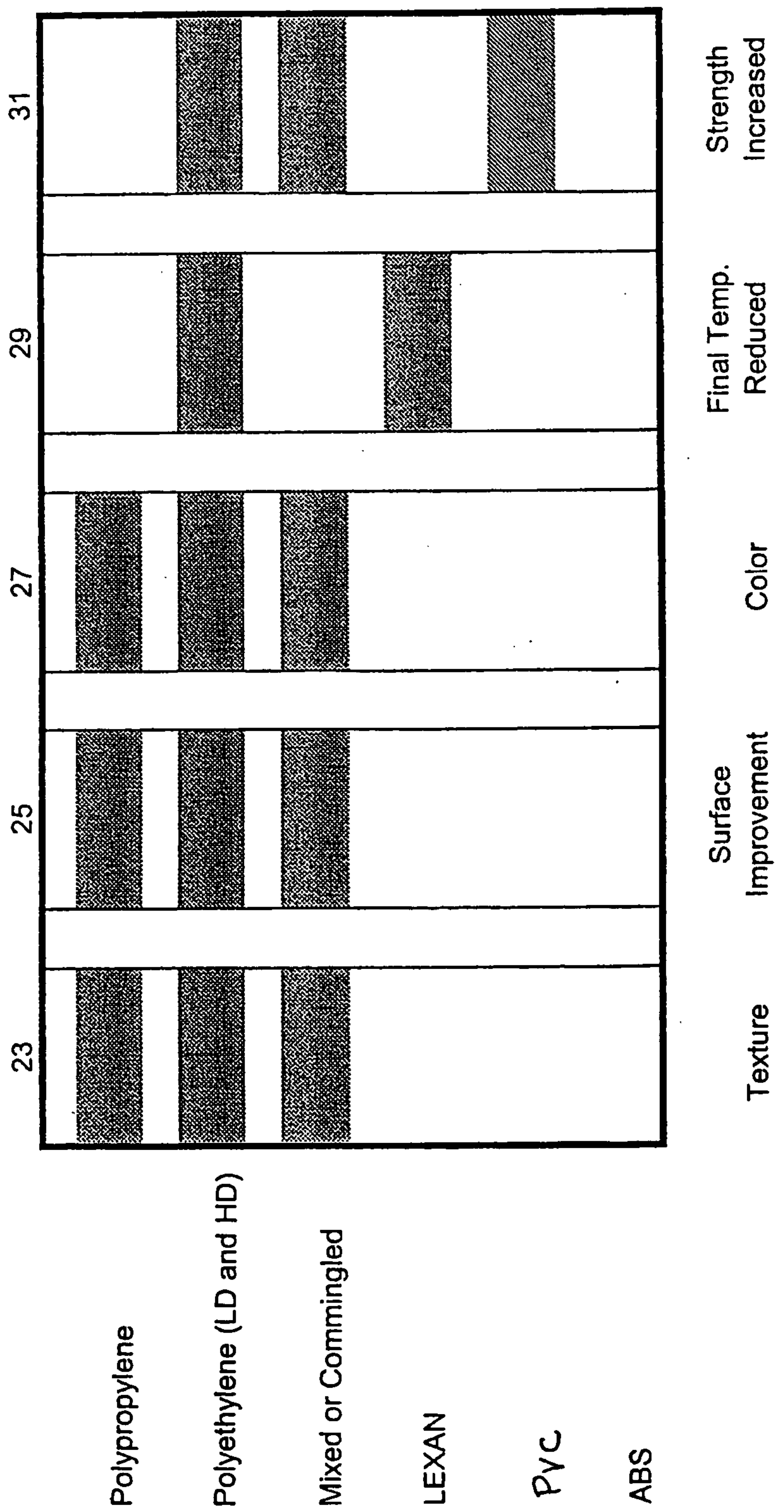


FIGURE 9


23
25
27
29
31
Texture
Surface Improvement
Color
Final Temp. Reduced
Strength Increased
Polypropylene
Polyethylene (LD and HD)
Mixed or Commingled
LEXAN
PVC
ABS

# INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 00/14268

**A. CLASSIFICATION OF SUBJECT MATTER**
IPC 7 C08K3/00 //(C08K3/00,3:22,3:36)

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 C08K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

WPI Data, EPO-Internal

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category * | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| X | DATABASE WPI<br>Section Ch, Week 198601<br>Derwent Publications Ltd., London, GB;<br>Class A60, AN 1986-004356<br>XP002147528<br>& JP 60 231729 A (ASAHI CHEM IND CO LTD),<br>18 November 1985 (1985-11-18)<br>abstract<br>--- | 1 |
| A | DATABASE WPI<br>Section Ch, Week 199348<br>Derwent Publications Ltd., London, GB;<br>Class A12, AN 1993-384145<br>XP002147529<br>& SU 1 775 428 A (KAMEN I SILIKATY RES<br>PRODN ASSOC),<br>15 November 1992 (1992-11-15)<br>abstract<br>---<br>-/-- | 1-14 |

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

* Special categories of cited documents :

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"P" document published prior to the international filing date but later than the priority date claimed

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 15 September 2000 | 29/09/2000 |

| Name and mailing address of the ISA | Authorized officer |
|---|---|
| European Patent Office, P.B. 5818 Patentlaan 2<br>NL – 2280 HV Rijswijk<br>Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,<br>Fax: (+31-70) 340-3016 | Siemens, T |

1

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 00/14268

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

| Category * | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| A | DD 292 007 A (OBERSPREE KABELWERKE VEB K) 18 July 1991 (1991-07-18) examples 1,2 | 1-14 |

1

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

# INTERNATIONAL SEARCH REPORT

Information on patent family members

Int ational Application No
PCT/US 00/14268

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|---|---|---|---|
| JP 60231729 A | 18-11-1985 | NONE | |
| SU 1775428 A | 15-11-1992 | NONE | |
| DD 292007 A | 18-07-1991 | NONE | |